

SECTION 16200—POWER GENERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK:

- A. The work covered under this section shall include the furnishing and installation of the devices, material and associated hardware as specified and/or indicated with all necessary electrical connections for complete installation of all power generation systems.

1.3 QUALITY ASSURANCE:

- A. The power system shall include a Caterpillar Power Systems, 1500 KW 3512B Series, electric generating set, 2500 amp thermal-magnetic load circuit breaker, battery charger, exhaust silencer, flexible exhaust connection, day tank, remote annunciator, transfer switches, weather protective housing, and rated for continuous standby service at 1500 KW, at .8 PF, 60 Hz, 277/480 Volts, 3 Phase.
- B. This system shall be built, tested and shipped by the manufacturer of the complete set, who has been regularly engaged in the production of engine-alternator sets and associated controls, for a minimum of ten years, so there is one source of supply and responsibility.
- C. To be classified as a manufacturer, the builder of the generating set must manufacture at least the engine or the alternator. All new equipment shall be "Year 2000 Certified."
- D. The manufacturer shall have printed literature and brochures describing the standard series specified (not a one of a kind fabrication). The manufacturer shall furnish schematic and wiring diagrams for the engine-alternator set, automatic transfer switches, and an interconnecting diagram showing connections to individual components, which constitute the standby power system.
- E. The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered which shall include:
 - 1. Maximum power level.
 - 2. Maximum motor starting capacity.
 - 3. Structural soundness.
 - 4. Torsigraph analysis per MIL-STD-705B, method 504.2.
 - 5. Fuel consumption.
 - 6. Engine-alternator cooling air flow.
 - 7. Transient response and steady state governing.
 - 8. Alternator temperature rise per NEMA MG1-22.40.

9. Harmonic analysis and voltage waveform deviation, per MIL-STD-705B, method 601.4.
 10. Three-phase short circuit test for mechanical and electrical strength.
- F. Test: Generator shall be tested under load conditions at factory for a minimum period of 8 hours.
- G. Warranty: The complete standby electric power system (equipped with set exerciser and running time meter) shall be warranted for a period of five years or fifteen hundred operating hours, whichever occurs first, from the date of initial start-up. The warranty must be provided by the system manufacturer. Multiple warranties for individual components (engine, alternator, controls, etc.), will not be acceptable. Satisfactory warranty documents must be provided.
- H. Onan and Kohler are approved equals.

PART 2 - PRODUCTS

2.1 STANDBY ELECTRIC GENERATING SYSTEM:

- A. The installation of a standby electric generating system shall include an electric plant consisting of, but not limited to, the following:
1. A diesel-driven electric plant to provide emergency electric power.
 2. Engine mounted start-stop control system.
 3. Automatic load transfer control to provide automatic starting and stopping of the plant and switching of the load.
 4. Mounted accessories as specified.
 5. Remote alarm annunciators.
 6. Day tank.
 7. Fuel tank and piping as specified in Division 15, Mechanical.
 8. Fuel tank, upon installation shall be completely filled with proper fuel by the Electrical Contractor.
 9. Provide hand pump for emergency engine priming, store in enclosure.
 10. Remote stop (break-glass type) for generator.

2.2 ENGINE:

- A. The engine shall be diesel-fueled, turbo-charged and four-cycle, liquid-cooled, with mounted radiator, fan and coolant pump. It shall have an operating speed of 1800- rpm. Intake and exhaust valves shall be heat resisting alloy steel, free rotating. Exhaust valve seal inserts shall be provided. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have coolant and oil filters with replaceable elements; lube oil cooler and a fuel transfer pump. Engine speed shall be governed by an electronic governor to maintain isochronous alternator frequency from no-load to full-load alternator output. The engine shall have a 24 Volt DC battery charging alternator with a transistorized voltage regulator. Remote, two-wire, starting shall be by 24 volt, solenoid shift, electric starters.
- B. Engine Protective Devices: Engine protective devices included shall provide an alarm circuit and/or shutdown for low engine temperature, overcrank, overspeed, plus preshutdown and shutdown for high coolant temperature and low oil pressure.

2.3 CONTROL CONSOLE:

- A. The control console shall be unit mounted with a inline, 3 pole, thermal-magnetic load circuit breaker designed to properly protect the generator and its feeders and the following AC and DC Controls:
1. DC Engine Controls (2-wire, 24 Volt system) include: run-stop-remotes, witch, remote start-stop terminals, oil pressure gauge, coolant temperature gauge, and battery voltmeter.
 2. Solid state engine monitoring system, modular design, with individual status, indicating lamps and signal circuits for connection to remote annunciator and common alarm terminal, per NFPA 110. The control console's front mounted status lamps indicate: low engine temperature, pre-shutdown and shutdown for high coolant temperature and low oil pressure, overcrank and overspeed, low water level and switch not in AUTO, manual reset and lamp test switch, low fuel main tank, generator supplying load, battery charger malfunctioning, low voltage in battery, low starting air pressure (if required), and low starting hydraulic pressure (if required).
 3. AC output controls include: AC voltmeter; AC ammeter; meter switch, voltmeter-ammeter phase selector with an OFF position; voltage adjusting rheostat; frequency meter; running time meter; exciter circuit breaker, manual reset; fine speed control potentiometer.

2.4 ALTERNATOR:

- A. The alternator shall be a 4-pole revolving field design drip-proof construction with the following features:
1. Stator: Skewed to minimize heating and voltage harmonics, with a 12-lead bus bar system and twice impregnated with varnish conforming to MIL-1-24092, Type M, Class 155.
 2. Rotor: Dynamically balanced with Amortisseur winding improving the AC waveform and act as a stabilizer for paralleling. It shall be permanently aligned to engine by a flexible disc coupling. The windings shall be vacuum impregnated with solid epoxy resin for improved cooling and environmental protection.
 3. Exciter: 3-phase, full-wave rectified with silicon diodes mounted on the rotor shaft with a field circuit breaker, manual reset and sized for maximum motor starting.
 4. Permanent Magnet Polor Excitor: A highly stable permanent magnet shall be mounted outboard of the bearing for easy serviceability.
 5. Voltage Regulator: Solid state and temperature compensated with silicon-controlled rectifiers and phase controlled sensing circuit.
 6. Insulation: Class F per NEMA MG1-1.65.
 7. Bearing: Double sealed, pre-lubricated ball bearing.
 8. Cooling: Direct drive centrifugal blower.

2.5 GENERATING SET PERFORMANCE:

- A. The generating set shall have performance characteristics as follows:
1. Waveform deviation factor, shall be less than 0.04 line-to-line, to reduce risk of overheating and of interference with sensitive communication equipment.
 2. Random frequency variation shall not exceed + 0.25 percent (+ 0.15 hertz); random voltage variation shall not exceed + 1 percent of its mean value for constant loads, from no load to full load.

3. Frequency regulation under varying loads, from no load to full load shall be isochronous. Voltage regulation under these conditions shall be + 2 percent.
4. Electromagnetic interference attenuation shall meet requirements of most industrial and commercial standards.
5. Total harmonic content of the AC waveform shall be less than 5 percent.
6. Telephone Influence Factor (TIF) shall be less than 50 per NEMA MG1-22.43.
7. Alternator temperature rise at rated load shall be within NEMA MG1-22.40
8. Continuous Standby Rating: These units will operate at the state rating for the duration of normal utility, power interruptions.

2.6 ACCESSORIES:

- A. The following accessories needed for the proper operation of the generating set shall include but not be limited to the following:

1. An engine mounted thermostatically controlled jacket water heater shall be provided to insure a minimum coolant temperature 49oC. ambient in a minimum room ambient of 0oC. The input voltage to the heater shall be the same as the output of the generator. The heater shall be disconnected whenever the engine starts.
2. A lead acid battery shall be supplied and shall be installed in a rack that is an integral part of the electric set base. The batteries shall have sufficient capacity for cranking the engine for at least 60 seconds at firing speed. The batteries shall be of capacity and voltage as recommended by the engine manufacturer. All necessary intercell connecting and battery cable shall be furnished. The batteries shall be supplied dry-charge and electrolyte added shortly prior to acceptance tests.
3. A battery charger with a maximum charge rate as recommended by the manufacturer shall be provided to maintain batteries at full capacity during standby conditions. An ammeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger shall be so designed that it will not be damaged during the engine cranking. The charger shall operate on 120 VAC, single phase power and may be furnished as a separate item with necessary cables and leads, or incorporated in the automatic transfer switch (only if U.L. listed with transfer switch).
4. An exhaust silencer, of the critical type, shall be furnished. The silencer shall be of chambered construction and shall provide maximum degree of silencing. It shall be sized to assure proper operation without excessive back pressure when installed in the exhaust system. The silencer shall be Electrical Contractor furnished and installed by Mechanical Contractor. The silencer shall be furnished with companion flanges.
5. The generating set shall be supplied with spring and pad type isolators for mounting between the base and the mounting surface.
6. Remote Annunciators: The remote annunciators shall be recessed and as manufactured by the Generator Manufacturer (provide trim piece to finish drywall next to panel) with the following alarm lights:
 - a. Overcrank
 - b. Low water temperature
 - c. High water temperature prealarm
 - d. High water temperature
 - e. Low lube oil pressure prealarm
 - f. Low lube oil pressure
 - g. Overspeed
 - h. Low fuel main tank

- i. High fuel day tank
 - j. Low fuel day tank
 - k. Control switch not in auto
 - l. Battery charger malfunction
 - m. Emergency generator running
 - n. Overcurrent device off normal
 - o. Lamp test switch
 - p. Alarm silence switch
 - q. Ground fault
 - r. Low voltage in battery
 - s. Low starting air pressure (if required)
 - t. Low starting hydraulic pressure (if required)
7. Outdoor Weather-proof Housing: Factory-assembled to generator set base and radiator cowl. Housing shall provide ample airflow for generator set operation. The housing shall have hinged side access doors and rear control door. All doors shall be lockable. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. Construction - Corner and side supports are 12-gauge steel. Louver access doors and housing top panels are 14-gauge steel. Solid control access doors are 16 gauge steel minimum. The weatherproof generator set enclosure shall be manufactured by same manufacturer as generator set. The enclosure shall be large enough to house the following equipment when bolted to the generator set frames
- a. Generator set
 - b. Day tank
 - c. Battery charger
 - d. Engine batteries
 - e. Load circuit breaker
 - f. Mufflers
8. A minimum 250-gallon day tank with float switch and low fuel alarm shall be furnished and installed next to the electric set. The day tank shall be new and unused and shall not be galvanized. The fuel system piping shall be no smaller than the minimum recommended by the engine manufacturer, to avoid fuel flow restriction. Flexible connections shall be provided.
9. Contractor shall provide battery heaters as required.
10. Provide a battery-powered light with a flexible cord and mounting clip (a flashlight is not acceptable).
11. Contractor shall provide low coolant shutdown for the engine.
12. Contractor shall provide a manual shut-off valve between the radiator and the coolant heater.

2.7 AUTOMATIC TRANSFER SWITCHES:

- A. The automatic transfer switch shall be supplied with a continuous electrical rating of sufficient amperage capacity to meet the requirements of both the maximum electric set output, and normal power service, 480 VAC, as specified below, and shall be compatible with the electric set.
- B. Operation:
- 1. The automatic transfer switches shall be supplied with precision calibrated voltage sensors to monitor the normal power source, and signal the electric set to start on a partial loss of power on any phase, or where feedback voltages exist. The voltage sensors shall

- be adjustable to signal startup when line voltage drops 5 percent to 20 percent below pickup voltage setting, and to signal shutdown when line voltage returns to 75 percent to 100 percent of normal voltage.
2. A time delay relay, adjustable for 0 to 6 seconds, shall delay the signal to start, to avoid nuisance start-ups on momentary voltage dips or power outages.
 3. When the electric set has reached proper rated voltage and frequency, determined by precision calibrated voltage sensors on the three phases of the emergency source, a time delay adjustable from 0 to 120 seconds, shall delay this transfer to allow the electric set to stabilize.
 4. The automatic transfer switches voltage sensors shall sense the return of normal power and a time delay, adjustable 0 to 32 minutes, shall delay the retransfer of the load to normal to avoid the short term normal power restoration, set at 20 minutes.
 5. After the load has been retransferred to normal source, a time delay adjustable 0 to 8 minutes, shall permit the electric set to run unloaded to cool down before shutdown, set at 5 minutes.
 6. The operating current for transfer and retransfer shall be obtained from the source to which the load is to be transferred. An automatic bypass shall re-transfer the load from the electric set to the normal source, if the electric set output interrupts after normal source restores voltage.
 7. A test switch shall be provided to simulate an interruption of power from the normal source.
 8. A clock exerciser shall be furnished to automatically start the electric set at regular intervals and allow it to run for a preset time period, minimum of 30 minutes per week. A selector switch shall permit selection of "without load" or "with load", the automatic transfer switch transfers the load to the electric set after appropriate time delays, the same as it would for a normal source interruption.
 9. A device to electrically disconnect the control section from the transfer switch, for maintenance service during normal operation shall be supplied.
 10. Provide programmed transition which allows the transfer switch to pause with neither normal or emergency power connected to the load while residual voltages decay on the connected loads. (Adjustable from 0.5 to 5.0 seconds).

C. Rating:

1. The transfer switches shall be rated for total systems load, including motor loads, electric discharge lamps, and tungsten filament loads. Tungsten filament loads are not to exceed 30% of the switches rating. The transfer switches shall be rated for continuous operation in ambient temperatures of -40oC (-40oF) to +67oC (142oF). The prototype transfer switches shall have passed the tests in Underwriter's Laboratories Bulletin 1008. The transfer switches shall be listed by Underwriters' Laboratories and approved by the Canadian Standards Association.
2. The prototype transfer switches shall have passed the Environmental Tests listed in Military Standard 202-E. The required methods are:
 - a. Method 101D, Test Condition B, Salt Spray (Corrosion)
 - b. Method 103B, Test Condition B, Humidity
 - c. Method 107D, Test Condition A, Thermal Shock
 - d. Method 110A, Sand and Dust
3. The prototype transfer switches shall have passed 50 cycles of operation, normal to emergency/emergency to normal, at 6 times rated current. The normal and emergency source voltage for this test shall be 600 VAC, 3 phase, connected 120o out of phase. A prototype transfer switch shall have passed short circuit closing tests. The source voltage

shall be 600 VAC, 3-phase, with available RMS current at least 20 times greater than the current rating of the transfer switches.

D. Construction:

1. The transfer switch shall be a mechanically held device utilizing fully enclosed contact assemblies operated by a transfer mechanism to provide double throw switching action.
2. The transfer mechanism shall be electrically operated by a single uni-directional gear motor with all parts in positive contact at all times. It shall also be capable of being operated manually safely and shall have suitable provisions for readily disengaging the gear motor when necessary. The transfer switch shall be mechanically and electrically interlocked so that a neutral position shall not be possible when under electrical operation unless a time delay neutral option is required, nor shall it be possible for load circuits to be connected to normal and alternate sources simultaneously, regardless of whether switch is electrically or manually operated. The switch shall have a manual neutral position. Manual operation shall be able to be accomplished by one person. The transfer switch mechanism shall provide a visual indication of transfer switch position.
3. The transfer switches shall have auxiliary switches rated at 25 amperes, 600 VAC, that are operated by the transfer switch in the normal or emergency position. These switches shall provide a normally open and/or normally closed contact for monitoring the transfer switches position, and controlling indicator lights or peripheral equipment.
4. Automatic transfer switches utilizing components of molded case circuit breakers, contractors or parts thereof, which have not been specifically designed for repetitive load transfer switching will not be accepted.
5. The transfer switches shall have emergency power, normal power and load connection lugs that are U.L. listed and C.S.A. approved for use with copper or aluminum conductors.
6. The following AC output controls shall be located on the face of the enclosure for all transfer switches:
 - a. AC voltmeter
 - b. AC ammeter
 - c. Meter switch
 - d. Voltmeter-ammeter phase selection with an "off" position
 - e. Frequency meter
7. Automatic transfer switch shall be ASCO, Onan or Russelelectric.

E. Enclosure:

1. The automatic transfer switches shall be enclosed in a NEMA 1 enclosure. The enclosure shall be heavy gauge, welded seam construction. The construction of the enclosure shall comply with applicable NEMA standards, and latest edition of NEC, as to strength, rigidity, and space.
2. The enclosure shall have pilot knockouts for convenient wire installation.
3. The wire bending space within the enclosure shall comply with the latest edition of NEC.
4. The enclosure shall contain a service panel, and a door lock with a key.
5. The automatic transfer switches shall have lamps that are front-mounted on the enclosure to indicate which source is supplying the power to the load.

F. Compliance and Operating Certifications:

1. The manufacturer of the automatic transfer switches shall certify compliance with Underwriter's Laboratories Standard for Safety, Automatic Transfer Switches, UL 1008. The certification shall be included in the submittal data.

2. An independent testing laboratory shall certify operational performance of the transfer switch series. The operational performance data shall be included in the submittal data.

PART 3 - EXECUTION

3.1 SUBMITTALS:

- A. The successful bidder shall provide complete and detailed submittal data adequate to determine compliance with the specification for components of the standby electric power system. All exceptions and deviation shall be clearly listed. Major exceptions to these specifications will be considered sufficient cause for rejection of bids.

3.2 INITIAL START-UP, SYSTEM CHECKOUT, & TEST:

- A. The complete installation shall be initially started and checked out for operational compliance by representatives of the manufacturer. The engine lubrication oil and antifreeze, as recommended by the manufacturer shall be provided by the supplier of the electric set.
- B. The Contractor shall make all necessary hook-ups to facilitate field-test and shall furnish all fuel necessary for, and perform a, field test of a minimum of 20 hours prior to the Consulting Engineer's review. Four hours of the test shall be conducted using available plus temporary load bank capacity so that full nameplate reading is utilized during test. He shall certify the installation for warranty purposes and file a field test report with the Consulting Engineer. The voltage, current and frequency readings shall be recorded at 15-minute intervals throughout all tests. There shall be a 15-minute unloaded run at the conclusion of the test to allow engine to cool before shutdown.
- C. The manufacturer shall have maintained a parts and service facility in the area for ten years, and shall coordinate the installation of this equipment with the trades involved. The Electrical Contractor shall assume responsibility for the entire emergency system and shall notify the manufacturer's representative before the installation has begun.
- D. The manufacturer shall provide service personnel to completely service and field test the emergency generator system for the Consulting Engineer's review for a minimum period of four hours during which time the manufacturer shall make any adjustments to the system to assure proper operation. The manufacturer shall then instruct the Owner's personnel as to proper maintenance and operation and furnish to Owner's personnel as to proper maintenance and operation and furnish to them written operating instructions.

3.3 INSTRUCTIONS AND DRAWINGS:

- A. Complete instructions, consisting of operating and maintenance manual, parts book, dimensional drawings, separate unit wiring diagrams and schematics and interconnecting wiring diagrams shall be provided.

3.4 INSTALLATION:

- A. Electrical Contractor shall ground the generator, frame and enclosure per the National Electric Code and as specified under Section 16400, Grounding. Do not ground generator neutral.
- B. Electrical Contractor shall completely fill storage tanks with the proper fuel for the generator after all tests.
- C. Electrical Contractor shall provide for the Consulting Engineer's review, certification by the Generator Manufacturer that the low fuel alarm operates for both the day tank and the main tank.
- D. The warranty for the complete standby electric power system, equipped with set exerciser and running time meter, including parts and labor, shall be for a period of five years or fifteen hundred operating hours, whichever occurs first, from the date of initial start-up. The warranty must be provided by the system manufacturer. Multiple warranties for individual components, engine, alternator, controls, etc., will not be acceptable. Satisfactory warranty documents shall be provided.

END OF SECTION 16200